Flight Systems Research Quarterly

An informal newsletter by and for participants of the UCLA/NASA Flight Systems Research Center

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Newsletter Background

The Flight Systems Research Center (FSRC), established in 1985 under a Memorandum-of-Agreement between UCLA and the NASA Ames-Dryden Flight Research Facility, is devoted to interdisciplinary research in flight systems and related technologies. Faculty from the Atmospheric Sciences, Computer Science, Electrical Engineering, Chemical Engineering, and Mechanical, Aerospace, and Nuclear Engineering Departments are currently associated with the Center. Professor A.V. Balakrishnan (EE) is the director, and Adjunct Associate Professor Kenneth W. Iliff (EE) is the associate director.

The need for cooperative research between universities and NASA centers is high, especially in light of the complex scientific and engineering problems being studied by both institutions. Responding to that need, the FSRC seeks to bring together the unique strengths and capabilities of UCLA with those of NASA-Dryden in a close working relationship so that mutual benefits and research goals can be realized.

It has been noted that improved communication between the organizations would better promote the Center's objective of active collaborative research. This newsletter was initiated to provide a forum of relevant information, updates, news, and views so that closer ties could be fostered between UCLA and Dryden. This newsletter does not substitute the need for regular conversation and meetings between students/professors and their NASA monitors. Rather, it serves to supplement the continued interchange of ideas and to report current areas of research interest and activity within the Flight Systems Research Center. Working together, we can better approach, analyze, and solve the multidisciplinary problems within the sphere of flight systems and technology.

Welcome to NASA Dryden

The Dryden Flight Research Facility (DFRF) is NASA's premier installation for aeronautical flight research. Located at Edwards, CA in the Mojave Desert, Dryden enjoys almost ideal weather for flight testing. In addition to a 500-mile high-speed flight corridor, more than 20,000 square miles of restricted airspace over California's high desert, known as the R-2508 Complex, are available for research flying. Situated adjacent to Rogers Dry Lake, a 44-square-mile natural playa for landing, the facility is in an isolated area free from problems of population disturbance or hazard.

The facility's primary research tools are research aircraft. In addition, ground-based facilities include a high temperature loads calibration laboratory that allows testing of complete aircraft and structural components under the combined effects of loads and heat; a highly developed aircraft flight instrumentation capability; a flight systems laboratory with a diversified capability for avionics system fabrication, development and operations; a water tunnel that allows basic flow mechanics to be seen on models or small components; a data analysis facility for processing of flight research data; a remotely piloted research vehicles facility and a test range communications and data transmission capability that links NASA's Western Aeronautical Test Range (WATR) facilities at Ames-Moffett, Crows Landing and Dryden.

These facilities have given Dryden pilots, engineers, scientists, and technicians a unique and highly specialized capability to conduct flight research programs unmatched anywhere in the world.

In this issue

News and Views

FSRC Colloquium: The annual FSRC Colloquium at Dryden (usually held in October) was rescheduled for early Spring 1994. In turn, the annual FSRC Research Review in LA (usually held in May) will now be in early Fall. This new yearly arrangement will provide better timing for both proposal preparation and research presentation. Individual UCLA/Dryden research groups are encouraged to schedule their own "meeting" this Fall in light of the Colloquium's postponement.

Speaking of carpools: Several grad students have expressed interest in visiting their NASA monitors more frequently. This can be done by "hitching rides" with other grad students driving up or arranging weekly or bimonthly carpools with fellow students. The commute is about 98 miles (each way) and takes about an hour and a half. Questions on travel reimbursement should be directed to your department accounting office. For more information on the "informal" carpools, please contact the editor.

F-16XL supersonic laminar flow aircraft

Current Major Projects at NASA/Dryden

The F-18 High Angle of Attack Research Vehicle (HARV): Dryden is flying a modified F-18 to study airflow, behavior of flight control surfaces, and engine performance at high angles of attack. The information is being gathered to create a data base for aircraft designers to accurately predict airflow over surfaces at high angles of attack. Technology is expected to result in control and performance improvements and better flight safety in future high performance aircraft, and help reduce costly design changes that sometimes are required during development. A thrust-vectoring system using spoon-shaped paddles has been installed and flown on the aircraft to direct engine exhaust flow. The thrust-vectoring system provides pitch and yaw control to enhance maneuverability and control of the research aircraft at high angles of attack.

F-18 High Alpha Research Vehicle (HARV)

F-18 Systems Research Aircraft (SRA): A second modified F-18 is being flown to test the newest and most advanced technologies such as electric actuators, fiber optics, and flush air data collection systems. The SRA is a faster, better, cheaper approach in systems development and is expected to help accelerate the transition of new aerospace concepts to U.S. industry.

F-15 HiDEC: The HiDEC (Highly Integrated Digital Electronic Control) F-15 program conducts flight research on integrated digital electronic flight and engine control systems and has demonstrated improved rates of climb, fuel savings, and engine thrust by optimizing systems performance based on mission and real-time needs. The HiDEC F-15 tested and evaluated a computerized self-repairing flight control system for the Air Force. The system can detect damaged or failed flight control components -- rudders, ailerons, elevators, flaps -- and reconfigure unaffected flight surfaces so that the pilot can maintain aircraft control to either complete the mission or land safely. The HiDEC was also used in a recent study that successfully showed that multi-engine aircraft with specially programmed flight control systems could be controlled and landed using just the engines for directional control if a failure of the aircraft's hydraulic system occurred.

F-16XL: NASA has demonstrated for the first time with an F-16XL aircraft laminar flow over a swept wing at supersonic speeds. Current wing designs produce turbulence at the wing surface and the penalty is decreased performance and fuel efficiency. The "XL" program at Dryden is investigating methods of minimizing the turbulent layer of air with an experimental wing section (called a glove) that draws off most of the turbulent air with a suction system. The laminar flow research could be an important step to increase flight efficiency and reduce fuel consumption of future high-speed civil transports. *(Continued on page 4.)*

Space Shuttle Endeavour

Students at Dryden

The Flight Systems Research Center invites and encourages UCLA grad students to spend a period at NASA-Dryden conducting their graduate research. Such an on-site arrangement can greatly enhance research direction and progress as students interact directly with NASA engineers and facilities. Room and board allowances are available for those desiring to work at NASA on a daily basis for an extended period (eg., summer, quarter, etc.). Other schemes such as weekly or monthly visits are also encouraged. For more information on these opportunities at Dryden, contact the editor.

This past summer, UCLA EE student, Kristyn Do, spent several weeks working at NASA-Dryden under the sponsorship of the FSRC. Kristyn worked on modeling the yaw jets of the Space Shuttle Reaction Control System. Using a Dryden-developed parameter estimation technique, she evaluated two control models by examining their stability and control derivatives. Other UCLA students working at Dryden this summer were Mike Cooper and Brian J. Peterson.

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Editor: K. Charles Wang (PRC Inc.)
P.O. Box 273, Bldg. 4800, Rm. 2024
Edwards, CA 93523-0273
(805) 258- 2107
{charles@wilbur.dfrf.nasa.gov}

FSRC Research Roundup

Leading edge cooling continues to be studied by Profs. Ivan Catton and Vijay Dhir, with graduate students J.Y. Lai and Gustave Stroes. Lai is nearly done with his research work on jet-impingement cooling and should graduate soon. Stroes is fabricating a new capillary wicking plate using composite materials and has plans to examine the effects of vibration on wicking power using the shaker tables at Dryden.

In related work, fluid flow and heat convection studies for actively cooled airframes are being undertaken by Brian Dempsey and Ben Tan under the lead of Prof. Tony Mills. Dempsey is using microencapsulated thermochromic liquid crystal (TLC) paint with digital imaging techniques to measure the convective heat transfer coefficients. The method should prove to be an effective and efficient design tool to validate cooling concepts for leading edges or more complex geometry structures.

Prof. Bob Kelly and Ph.D. candidate Oshin Peroomian are refining their direct numerical simulations of instabilities in compressible shear layers. Peroomian recently attended the ICASE conference on transition, turbulence, and combustion at NASA Langley. Future plans are being considered to apply his codes to examine instabilities in subsonic and supersonic shear layers.

David Huckaby and John Mendoza are working together on modelling the hypersonics of the Pegasus launch vehicle. A review of their progress through August 1992 can be found in NASA CR 186023. Current focus is on better understanding the transition regime from both an analytical and numerical view. Turbulence modeling will be performed using a turbulence code written in conjuction with D.C. Wilcox.

Profs. Owen Smith and Ann Karagozian and former student Charles Wang, are awaiting the availability of NASA's F-104G #826 to fly their experiments examining transverse jet injection into transonic and supersonic crossflows. The experimental apparatus was flight qualified this past summer, having passed both environmental and vibrational test procedures. Scheduling for other flight experiments on #826 have pushed the flight date to December of this year.

Logan Brashear visited Dryden several times this summer to meet with NASA engineers Tim Moes and Dr. Tony Whitmore. Working under his advisor, Prof. Nhan Levan, Brashear is investigating improved methods of estimating air data parameters during dynamic flight, particularly where unsteady flow is present.

Eric Shank was also at Dryden this summer, continuing his work with NASA engineer Lee Duke in optimizing the computer work environment for engineering data analysis. Along with E. Robert Tisdale, Shank works with Prof. Walter Karplus in the CS department.

Prof. Kung Yao continues his work in new nonlinear least squares and total least squares techniques with Jeff Kong and Dr. Flavio Lorenzelli. Applications involve load measurement problems with existing F-111 aircraft data. Jose Diaz and Dongrin Kim visited Dryden with Prof. Yao to meet with Phil Hamory and colleagues. They are working together on developing a spread spectrum avionic telemetry system that would revolutionize the way sensor data is transmitted on an aircraft.

[*Future issues will discuss other research groups and their work. Graduate students are invited to submit short summaries that will be published in the above section.*]

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SR-71: A trio of triple-sonic SR-71s has been loaned to NASA by the Air Force and are being used at Dryden for aeronautical research that calls for high speed, high-altitude environments. Data collected by the SR-71 "Blackbirds" will help in the development of future high speed military and civil aircraft, including the HSCT. Current work involves infrared astronomy with JPL and sonic boom reduction tests.

X-31: The X-31 International Test Organization (ITO) is located at Dryden and flight test operations with the two thrust-vectored vehicles are expected to continue at Dryden through 1993. The two X-31s are being flown in a program managed by the Advanced Research Projects Agency to demonstrate the value of thrust vectoring, coupled with an advanced flight control system, for close-in air combat maneuvering at high angles of attack. The information could be applied to the development of highly maneuverable next-generation fighters.

B-52: The NASA B-52 aircraft is currently being used to test the F-111 crew capsule parachute recovery system for the Air Force and it is the launch aircraft for the commercially developed Pegasus space booster system. Released from the B-52 in the same manner as the legendary X-15 manned hypersonic vehicle, Pegasus powers itself up to an altitude of 200,000 feet at a speed of nearly Mach 8.0 before a secondary stage takes over. A third stage delivers its payload into low-Earth orbit.

F-15 ACTIVE: A highly modified F-15 is expected to begin flying in late 1993 using a multi-axis thrust vectoring system, linked to an advanced flight control system that includes active canards, in a program called ACTIVE (advanced control technology for integrated vehicles).

The Future Direction of Hypersonics

Although fundamental hypersonic research continues, actual hypersonic flight experiments are still a few years away. Some 30 years ago, there was much interest in hypersonic aircraft; it was believed to be a natural step on the road to space. But that evolutionary progression was overshadowed by the advent of ballistic missile and rocket technology. Recent interest has been to try and reduce the cost of access to space via winged air-breathing hypersonic aircraft. And this was why the NASP (National Aero-Space Plane) was born in the mid-80s.

Recently however, the NASP X-30 has become less of a manned flight test program and more of a technology development program due to technical obstacles as well as funding problems. A smaller scale developmental flight test vehicle has been proposed, called HYFLITE (Hypersonic Flight Test Experiment). HYFLITE is a sub-scale unmanned experiment that would be flown off a low cost expendable ballistic missile. The design takes much of the NASP geometry, and is intended to find the answers to heating, aerodynamic, and propulsion questions.

A related concept being studied at NASA-Dryden involves a sub-scale flight vehicle that would be carried to altitude in piggyback fashion on an SR-71 (see photo below), from which it would then launch and accelerate to Mach 10 with scramjet engines. Yet another NASP technology demonstrator proposed by Dryden is the SWERVE (Sandia Winged Energetic Reentry Vehicle) which is a cone shaped hypersonic drone that would be launched off the front of the Pegasus booster rocket.

While the future of hypersonic aircraft may appear unsettled, generic hypersonic experiments have been flown aboard the Space Shuttle and the Pegasus. Other programs are presently being proposed and planned for. For now, the goal of a low-cost, manned, air-breathing, Single-Stage-To-Orbit (SSTO), hypersonic aircraft remains several years ahead; but the work required to get there still exists for those who actively pursue it.

The only operational SR-71s are at NASA Dryden as high speed/altitude research platforms.